

books. But who reads blue-books? Farmers cannot perform successfully a feat which almost baffles the best-trained member of Parliament. What they want is a Department of Agriculture which shall improve the laws of the land, as well as investigate obscure subjects, and circulate the official reports in the manner of the United States department, in editions of a quarter of a million. The United States Commissioner not only expounds the laws of the federation on roads, fences, &c.; but he learns, for instance, that the beet sugar industry of Europe, and the system of agricultural education in Germany and other countries, present instructive features to the intelligent agriculturist, and he therefore sends a qualified commissioner to report on each of these subjects. American farmers are thus enlightened on European agriculture sooner and more authoritatively than we, who are separated from the Continent by nothing more than a "streak of silver sea." There are our Colonies also; and we would on their behalf inquire whether an intending emigrant to Canada, New Zealand, Australia, or the Cape, can obtain as much reliable information on their agriculture as the American farmer now possesses about his country's recent purchase, Alaska? It thus seems clear that the United States Department of Agriculture presents features which may be profitably copied by our Executive Government, and others which are equally instructive both to our agriculturists and to our men of science.

AGASSIZ'S SEASIDE STUDIES

Seaside Studies in Natural History. By Elizabeth and Alexander Agassiz. Marine Animals of Massachusetts Bay: Radiates. 2nd ed. (London: Trübner & Co., 1871.)

THIS is a reprint, with a few additions, of the charming work which became so popular in America and in England some five years since on account of its intrinsic merits and the beauty of the illustrations. The book includes descriptions and more or less truthful illustrations of the Actiniæ, Madreporaria, Alcyoninae, Acalephæ, Hydroids, Holothurians, Echinoidea, and Asteroidea which may be found in the neighbourhood of Massachusetts Bay. The history of the development of many of the forms is carefully written, and is obviously the result of patient original observation.

In noticing the reproduction of the Actiniæ the authors remark that the eggs which hang on to the inner edge of the partitions of the visceral cavity drop off into it during different stages of development. Ordinarily they are passed out through the mouth as Planula-shaped ciliated creatures, which soon become attached to a foreign substance. The base enlarges, and the free extremity falls in to form a concavity, the future gastric and visceral cavity. But sometimes the embryo is provided with tentacles and with its stomachal cavity before it escapes. Lacaze-Duthiers has described a similar state of things in the reproduction of *Corallium rubrum*, and probably the embryonic condition of all the stony corals is that of a free swimming sac which undergoes metamorphosis. These usually sedentary Actiniæ are not without nomadic species, and *Arachnactis brachiola* A. Ag. is described as a small floating anemone, very nocturnal in its habits, which swims

with its tentacles and mouth downwards, using the body as a float. This form is not quite symmetrical, and has an evident tendency towards establishing a longitudinal axis. The mouth is out of the centre. Bicornium is noticed as selecting the mouth-folds of the common large red Cyanea as its home. It undergoes retrograde development, and its tentacles are short and stout on account of its parasitic existence.

The only stony coral described is the littoral *Astrangia*, which is probably a descendant of the miocene forms which once flourished on the same area. The tentacles of this coral are covered with wart-shaped masses, crowded with nematocyst lasso cells. Such forms as *Caryophyllia* and *Balanophyllia*, which are so well represented on our coasts and in thirty fathom water, do not appear to have been found by the authors in Massachusetts Bay. Amongst the Acalephæ, *Cyanea*, of course, is well described, and it is observed that so large a portion of its bulk consists of water that one of no less than thirty-four pounds weight being left to dry in the sun for some days, was found to have lost 99 per cent. of its original weight. Writing of the not very attractive appearance of these huge jelly fish, Agassiz observes that "to form an idea of his true appearance, one must meet him as he swims along at midday, rather lazily withal, his huge semi-transparent disc with its flexible lobed margin glittering in the sun and his tentacles floating to a distance of many yards behind him. Encountering one of these huge jelly fishes when out in a rowing boat, we attempted to make a rough measurement of his dimensions upon the spot. He was lying quietly near the surface, and did not seem in the least disturbed by the proceeding, but allowed the oar, eight feet in length, to be laid across the disc, which proved to be seven feet in diameter. Backing the boat slowly along the line of the tentacles, which were floating at their utmost extension behind him, we measured these in the same manner, and found them to be rather more than fourteen times the length of the oar, thus covering a space of some hundred and twelve feet." This huge mass is produced by a hydroid measuring not more than half an inch in length when full grown.

The parasitic early life of *Campanella pachyderma* A. Ag. appears to throw a doubt whether this acaleph passes through the hydroid state or not. Should the eggs develop at once into the medusa in this instance, there is no small significance to be attached to the fact. An anomaly of an opposite character is noticed in the case of *Laomeda amphora* Ag. This campanularian develops medusæ which never separate from the parent hydroid, but wither on its stem after having laid their eggs. The development of these abortive medusæ is not far advanced. This species flourishes in the sewage of Boston. There is a very admirable drawing of *Tubularia Couthouyi* Ag., a tubularian whose medusæ buds are never freed from the stem, and do not develop into full-grown jelly fish, but always remain abortive. These buds cluster like a bunch of grapes under the expanded umbrella-shaped tentacles of the hydroid, which are gracefully supported by a curved stem.

The process of the budding of the medusæ of *Hybocodon*, where small jelly fish similar to the original grow by gemmation from a large tentacle, is well described, and the hydroid stage and general want of symmetry in the

medusa also. Then the budding from the proboscis of *Dysmorphosa fulgurans* A. Ag. is noticed, and the nomadic or free-floating hydroid *Nanomia* also. Synapta, amongst the Holothurians, is noticed on account of its curious sand-ring clothing. "They live in very coarse mud, but they surround themselves with a thin envelope of fine sand, which they form by selecting the smaller particles with their tentacles, and making a ring around their anterior extremity. This ring they then push down along the length of the body, and continue the process, adding ring after ring, till they have entirely encircled themselves with a sand tube. They move the rings down partly by means of contractions of the body, but also by the aid of innumerable appendages over the whole surface. To the naked eye these appendages appear like little specks on the skin; but under the microscope they are seen to be little warts projecting from the surface, each one containing a little anchor with the arms turned upward. Around the mouth the warts are larger, but do not contain any anchors." "By means of these appendages, though aided also by the contractions of the body, the Synapta move through the mud, and collect around themselves the sand tube in which they are encased." They gorge themselves with mud and sand for the sake of the nutritious substances they may contain. The office of the pedicellariæ of the Sea Urchin is well described, as follows:—"If we watch the Sea Urchin after he has been feeding, we shall learn at least one of the offices which this singular organ performs in the general economy of the animal. That part of his food which he ejects passes out at an opening on the summit of the body, in the small area where all the zones converge. The rejected particle is received on one of these little forks, which closes upon it like a forceps, and it is passed on from one to the other down the side of the body till it is dropped off into the water. Nothing is more curious and entertaining than to watch the neatness and accuracy with which this process is performed. One may see the rejected bits of food passing rapidly along the lines upon which these pedicellariæ occur in greatest number, as if they were so many little roads for the carrying away of the refuse matters; nor do the forks cease from their labour till the surface of the animal is completely clean and free from any foreign substance." Some higher animals might take a profitable lesson from the Urchin. The Crinoids are passed by rather briefly. The existence of Comatulæ from Greenland to South Carolina is mentioned, but the authors do not appear to have devoted special attention to them. A very excellent notice of the embryology of the Echinodermata precedes the last chapter, which consists of a brief *résumé* of the distribution of life in the ocean. The book might be taken as a model by many European naturalists who write popular works, for there is a vast amount of philosophy in it. The authors have not contented themselves with serving up a number of "wonders" for the public bewilderment; nor have they simply given us a series of descriptions of forms, as is the practice especially amongst those who trade upon butterflies and beetles; but they have taken a vast amount of trouble in explaining the development and embryology of the Invertebrata which have come under their notice. In fact, they have given a reasonable amount of bread with their "sack."

P. M. D.

EARNSHAW'S DIFFERENTIAL EQUATIONS

Partial Differential Equations. An Essay towards an entirely new Method of Integrating them. By S. Earnshaw, M.A. (Macmillan and Co., 1871.)

THE present work, as its title indicates, contains a detailed explanation of a new method of integrating Partial Differential Equations; it is in no sense a textbook or introduction to the subject. The author's object is not to collect and describe the known methods, but to develop a new one. The principle of the method is easily explained and understood. The independent variables in the given differential equation being $t, x, y, z, \dots$, we can transform it so that the new independent variables are $t, \xi, \eta, \zeta, \dots$, by equations of the form $D_t u = d_t u + d_\xi u \cdot D_\xi x + \dots$; but the practical application of the method consists in comparing the original equation with the equation last written, and thus determining relations from which, by the elimination of $\xi, \eta, \zeta, \dots$, the integral of the original differential equation is found. The quantities $t, \xi, \eta, \zeta, \dots$, with the exception of the one with regard to which the differentiation is being performed, are treated as constants, and are here called *quasi-constants* (semi-constants we should have preferred). Mr. Earnshaw, as is apparent from the equation of transformation quoted above, adopts d when the differentiation is with regard to the old variables, and D when with regard to the new; the suffix notation for differential coefficients is also made use of. For this latter departure from custom the author in the preface offers an apology, and states that he has been warned that it "will form a serious hindrance to the acceptableness of the present work." This fear we think is groundless; the notation is not inconvenient in such investigations as the present, as it somewhat simplifies the appearance of the equations without rendering the analysis more difficult to follow.

In the first few chapters the method is applied to the integration of numerous equations of the first and second orders, and throughout the book the applications to particular cases are so numerous that whole chapters consist entirely of "examples worked out." This excessive number of examples is a drawback, as many of them (for instance, all in Chapter V., which treats of linear equations of the second order with constant coefficients) can be more simply and perfectly discussed by Boole's symbolic and other methods. The reader is also left in doubt as to how far the examples have been chosen so as to suit the method of solution here adopted. In the development of a new principle it is always a matter of great importance to point out the cases in which it enables us to obtain results previously beyond our reach, and also the cases in which the previous methods are preferable. This Mr. Earnshaw does not appear to have done; he has integrated a great number of equations, many of which, however, are capable of solution by well-known methods in as straightforward a way as ordinary quadratics in algebra. It is, for such reasons as these, generally desirable that original mathematical investigations should appear first in the memoirs of a Society or other recognised organ, where the new matter is distinctly stated, rather than in the form of a book where there is nothing to check the temptation to overburden the explanation with examples. Mr. Earnshaw claims to have for the first time integrated in